ARROW → Fast, Accurate and Sparse Automatic Facade Reconstruction from Unstructured Ground Laser-Scans

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CITYSCAPE DIGITAL

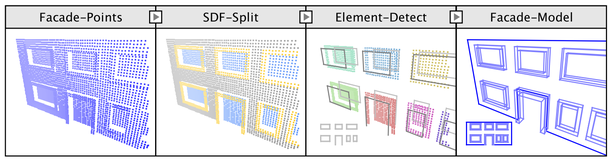
CDE Centre for Digital Entertainment

EPSRC Engineering and Physical Sciences Research Council

1 → Introduction

What → an efficient data-driven approach to reconstructing 3D architectural facade models from unstructured LiDAR point-clouds.
Why → Surface-reconstruction yields dense mesh [3], which are often too heavy for real-time simulation. Template-driven methods (that exploit facade split-grammars [1]) have low accuracy on irregular facades. Data-driven sparse methods lack semantic structure [2].
Advantages, Applications & Benefits → clean, semantically-rich models without RGB data.

2 → Approach



Accurate
Railed
Reconstruction of
Openings and
Walls

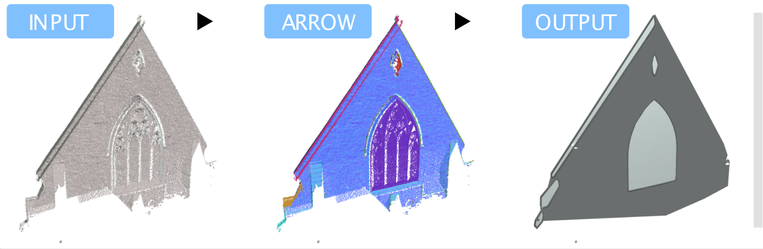
points ↓ in ↓ **ARROW** ↓ out ↓ mesh

a new algorithm based on quad dominant wall meshing and railed 3D sweeps.

Step 1: filter points based on verticality.
Step 2: localise on wall using filtered points.
Step 3: binary split: wall vs interest points.
Step 4: extract connected-components from interest-points using KD-tree.
Step 5: rail segmented surface-elements.
Step 6: quad dominant cut-out wall mesh.
Step 7: return facade → { wall, elements }.

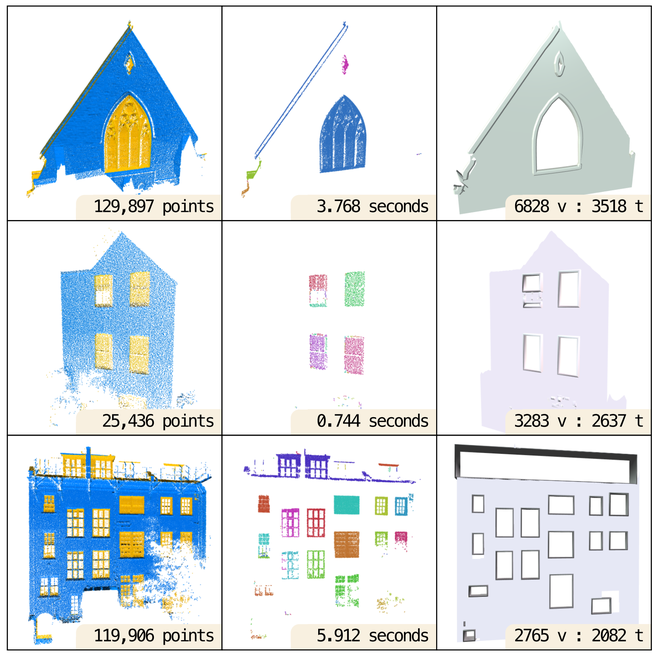
3 → The ARROW Algorithm Illustrated

The Key Idea polygon-clipping and 3D-sweeps.

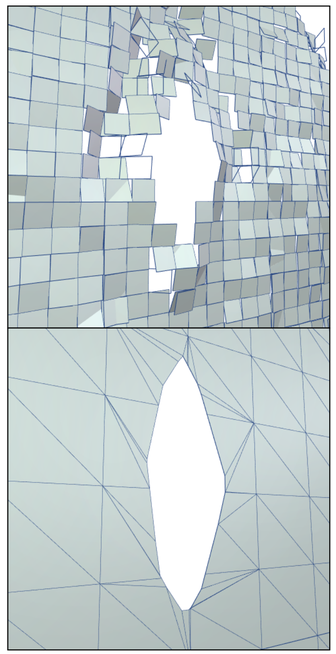


Intermediary data → (from left to right, top to base) quantized wall-point filter response, binary division from the SDF-split (wall-points in gray, interest-points in blue), KD-tree used to 'chunk' sets of deviant points, connected component clusters from KD-tree chunks, railed surface-element models, and finally quad-dominant wall model.

4 → Experimental Results



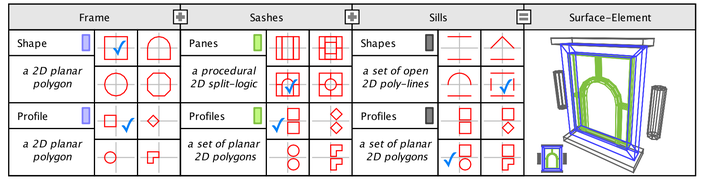
(left to right) input-points treated with SDF split, connected-components segmented using KD-tree, and finally the output railed facade model.



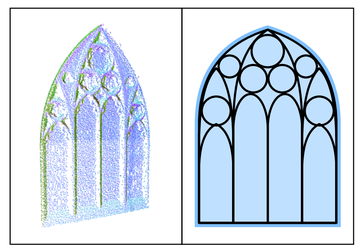
the regular assortment of planes ↑, versus the ARROW algorithm ↓.

The initial results are promising in terms of speed, brevity and geometric accuracy. The next stage is to quantify the accuracy relative to human CAD technicians by considering the precision and recall of the window detection.

5 → Further Research



Data-Driven modelling of segmented window and door point clusters: (top) the abstract representation of a surface-element, and (right) the key task - 2D split-logic resolution.



6 → References

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